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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/811,442	03/26/2004	Liang Liu	US4080	1467

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EXAMINER	
CANNING, ANTHONY J	
ART UNIT	PAPER NUMBER
2879	

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	04/19/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

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Office Action Summary	Application No.	Applicant(s)	
	10/811,442	LIU ET AL.	
	Examiner	Art Unit	
	Anthony J. Canning	2879	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *23 January 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,3-9 and 11-20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *16-20* is/are allowed.

6)☒ Claim(s) *1,3-9 and 11-20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Acknowledgement of Amendment

1. The amendment to the instant application was entered on 23 January 2007.

Terminal Disclaimer

2. The terminal disclaimer filed on 23 January 2007 disclaiming the terminal portion of any patent granted on this application, which would extend beyond the expiration date of U.S. 7,115,013 has been reviewed and is accepted. The terminal disclaimer has been recorded.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1, 4-9 and 11-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakamoto (U.S. 6,097,138) in view of Dai et al. (U.S. 6,232,706 B1).

5. As to claim 1, Nakamoto discloses a carbon nanotube-based field emission device (column 2, lines 24-29) comprising: a cathode electrode (see Fig. 6C, item 46; column 9, lines 21-25); and a carbon nanotube array of nanotube members (see Fig. 6C, item 26; column 9, lines 27-29), the carbon nanotube array of the nanotube members extending from a root end to a

growth end (see Figs. 6A-6C; column 9, lines 6-20), the carbon nanotube array being aligned perpendicularly from the cathode electrode (see Fig. 6C, item 26) and having a growth end embedded in the cathode electrode and an opposite root end (see Figs. 6A-6C; column 9, lines 5-20); wherein the growth end of the carbon nanotube array is in electrical contact with the cathode electrode (see Fig. 6C, items 26 and 46; column 9, lines 21-29), and the root end defines a substantially planar surface (see Fig. 6C, item 26; the carbon nanotubes are grown on the first electrode, item 42, in figure 6A and then moved onto a substrate, item 44, in figure 6B, then the first electrode, item 42, is removed, this is the same method as disclosed in the instant specification, see paragraphs 0023-0025). Nakamoto is silent in regards to the root end has a specific flatness of less than one micron across the nanotube array.

In the same field of endeavor, Dai et al. disclose a field emission device with a variation flatness of the planar surface less than 1 micron (column 3, lines 19-32; column 4, lines 11-15; here it says that the nanotubes can have a flat surface, which the examiner interprets to mean completely flat and therefore a variation less than 1 micron). Having uniformly flat nanotubes allows for desirable emission of electrons.

Therefore, it would have been obvious to one having ordinary skill in the art, at the time the invention was made, to modify the field emission device of Nakamoto to include nanotubes with a variation in flatness of the planar surface is less than 1 micron, as taught by Dai et al., for the desirable emission of electrons.

6. As to claim 9, Nakamoto discloses a carbon nanotube-based field emission device (column 2, lines 24-29) comprising: a cathode electrode (see Fig. 6C, item 46; column 9, lines 21-25); and a carbon nanotube array of nanotube members (see Fig. 6C, item 26; column 9, lines

27-29), the carbon nanotube array of the nanotube members extending from a root end to a growth end (see Figs. 6A-6C; column 9, lines 6-20), the carbon nanotube array being aligned perpendicularly from the cathode electrode (see Fig. 6C, item 26) and having a growth end embedded in the cathode electrode and an opposite root end (see Figs. 6A-6C; column 9, lines 5-20); wherein the growth end of the carbon nanotube array is in electrical contact with the cathode electrode (see Fig. 6C, items 26 and 46; column 9, lines 21-29), and the root end defines a substantially planar surface (see Fig. 6C, item 26; the carbon nanotubes are grown on the first electrode, item 42, in figure 6A and then moved onto a substrate, item 44, in figure 6B, then the first electrode, item 42, is removed, this is the same method as disclosed in the instant specification, see paragraphs 0023-0025). Nakamoto is silent in regards to the root end has a specific flatness of less than one micron across the nanotube array.

In the same field of endeavor, Dai et al. disclose a field emission device with a variation flatness of the planar surface less than 1 micron (column 3, lines 19-32; column 4, lines 11-15; here it says that the nanotubes can have a flat surface, which the examiner interprets to mean completely flat and therefore a variation less than 1 micron). Having uniformly flat nanotubes allows for desirable emission of electrons.

Therefore, it would have been obvious to one having ordinary skill in the art, at the time the invention was made, to modify the field emission device of Nakamoto to include nanotubes with a variation in flatness of the planar surface is less than 1 micron, as taught by Dai et al., for the desirable emission of electrons.

7. As to claims 4 and 11, Nakamoto and Dai et al. disclose the field emission device as described in claims 1 and 9. Nakamoto further disclose that the carbon nanotube array comprises

a plurality of carbon nanotubes, each of which has an open tip (carbon nanotubes by definition are hollow carbon structures).

8. As to claims 5, 6, 12, and 13, Nakamoto and Dai et al. disclose the field emission device as described in claims 1 and 9. Nakamoto further discloses that the height of the carbon nanotube array is in the range from 5 microns to 10 mm, more specifically between 10 to 500 microns (column 5, lines 1-13, using the diameter and the aspect ratio the claimed range can be calculated.

9. As to claim 7, Nakamoto and Dai et al. disclose the field emission device as described in claim 1. Nakamoto further disclose an insulative barrier (see Fig. 8C, item 52; column 11, lines 5-9) having a height just exceeding the planar surface of the root end is formed adjacent the carbon nanotube array and at least a gate electrode (see Fig. 8C, item 54; column 11, lines 5-9) is formed on the barrier such that the gate electrode is separated from the cathode electrode (see Fig. 9C, items 28 and 54; column 5-20).

10. As to claim 8, Nakamoto and Dai et al. disclose the field emission device as described in claim 7. Nakamoto further disclose that the root end of the carbon nanotube array almost reaches the interface between the barrier and the gate electrode (see Fig. 8C, item 15; column 10, lines 49-56; since almost is a not any definite amount, the examiner interprets the height of the carbon nanotubes in the figure to be about the same height as the insulating barrier ribs).

11. As to claim 14, Nakamoto and Dai et al. disclose the field emission device as described in claim 9. Nakamoto further disclose at least a gate electrode is formed adjacent the carbon nanotube array at a height above the planar surface of the root end (see Fig. 8C, item 54).

12. As to claim 15, Nakamoto and Dai et al. disclose the field emission device as described in claim 14. Nakamoto further disclose the gate electrode is supported by an insulative barrier formed adjacent the carbon nanotube array (see Fig. 8C, item 52; column 11, lines 5-9), such that the gate electrode is separated from the cathode electrode (see Fig. 8C, item 28; column 11, lines 5-9).

13. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakamoto (U.S. 6,097,138) in view of Dai et al. (U.S. 6,232,706 B1) and in further view of Han et al. (U.S. 6,097,138).

14. As to claim 3, Nakamoto and Dai et al. disclose the field emission device as described in claim 1. Nakamoto and Dai et al. fail to specifically disclose that the cathode electrode is made of copper.

In the same field of endeavor, Han et al. discloses a field emission display, which has a cathode electrode, made of copper (column 4, lines 60-62). Copper makes ideal cathodes due to its conductive properties.

Therefore, it would have been obvious to one having ordinary skill in the art, at the time the invention was made, to modify the field emission device of Nakamoto to include a copper cathode, as taught by Han et al., to take advantage of copper's ideal conductive properties.

Response to Arguments

15. Applicant's arguments, see Remarks, filed 23 January 2007, with respect to the rejection(s) of claim(s) 1, 4, 7-9, 11, 14 and 15 under 35 U.S.C. 103(a) have been fully

considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Nakamoto (U.S. 6,097,138).

Allowable Subject Matter

16. Claims 16-20 are allowed.

The following is an examiner's statement of reasons for allowance:

17. As to claim 16, the prior art of record fails to teach or reasonably suggest a method of making a carbon nanotube-based field emission device including all the limitations of claim 16, specifically growing a carbon nanotube array on the catalyst layer wherein carbon nanotubes in the array extend from the catalyst layer with flat roots and define different heights with tips, applying a cathode electrode to the tips of the carbon nanotubes, and separating the carbon nanotubes from the catalyst layer and exposing the flat roots so that the flat roots of the carbon nanotubes are configured for acting as electron emission ends of the carbon nanotube-based field emission device.

18. Claims 17-20 are allowed for the reasons given for claim 16, and for depending from claim 16.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Contact Information

19. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Anthony J. Canning whose telephone number is (571)-272-2486. The examiner can normally be reached on M-F 8:00-4:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nimesh D. Patel can be reached on (571)-272-2457. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Anthony Canning
2 April 2007

KARABI GUHARAY
PRIMARY EXAMINER